

REMARKS

By this response, claims 1, 2, 6-8 and 15-17 have been amended. Claims 1-20 are pending in the application. Support for the claim amendments is provided in the present specification at, for example, the paragraph bridging pages 9 to 10; page 11, lines 11-18 (see claims 8 and 17); page 14, line 7 to page 15, line 14; the paragraph bridging pages 19 to 20; and page 20, lines 10-12. The specification has been amended to correct typographical errors and to make the "DISCLOSURE OF THE INVENTION" section consistent with the amended claims. Applicants submit that no new matter has been added by the amendments.

Reconsideration and allowance are respectfully requested in view of the following remarks.

Drawings

The Examiner is respectfully requested to indicate in the next Patent Office communication whether the proposed drawing changes submitted on April 3, 2002, are acceptable.

Priority Under 35 U.S.C. § 119

The present application is a U.S. National Stage of International Application No. PCT/JP01/06724, and claims foreign priority to JP 2000-244026. A copy of the Form PCT/IB/304 (Notification Concerning Submission or Transmittal of Priority Document), which indicates the date of receipt of the priority document (September 21, 2001), was filed on April 3, 2002. However, receipt of the certified copy of the priority document is not acknowledged in the form PTOL-326 provided with the

Office Action. According to PCT Rule 17.2, “[n]o such Office shall ask the applicant himself to furnish it with a copy [of the priority document].” In order to expedite prosecution, however, Applicants contacted the Office of PCT Legal Administration and were informed that the Office will request that a copy of the priority document be forwarded to the USPTO. The Examiner is respectfully requested to confirm that such copy has been received by the USPTO and to acknowledge in the next Patent Office communication the claim for foreign priority and receipt of the certified copy of the priority document.

Rejection Under 35 U.S.C. § 102

Claims 1-20 stand rejected under 35 U.S.C. § 102(e) over U.S. Patent No. 6,072,576 (“McDonald”) for the reasons stated at page 2 of the Official Action. The rejection is respectfully traversed.

Claim 1, as amended, recites “a method for controlling production process without having resort to preparation of a calibration curve, the method comprising: taking an absorbance spectrum for each of a plurality of standard samples collected from a production process step in an analysis range including near-infrared region, constructing a data base from a differentiation curve of a near-infrared spectrum chart obtained using a plurality of production products that had been judged by conventional chemical analysis to be rated products, by calculating standard deviations and the average intensity of the standard samples (standard average intensity) in respect of each wave length selected from the spectrum included in the analysis range, taking an absorbance spectrum in the analysis range for each analysis sample collected from the production process step and comparing the

resulting absorbance spectrum with the data base, estimating deviation (analysis deviation) of the intensity of the absorbance spectrum of each of the analysis samples (analysis intensity) at each of the selected wave lengths from the standard average intensity, comparing, when the absorbance spectrum includes wave length(s) at which the analysis deviation of the absorbance spectrum of the analysis sample is outside a tolerance limit, the wave length showing the analysis deviation of the absorbance spectrum outside the tolerance limit with production information given preliminarily in the data base in order to find out what the control factor is to thereby obtain control data and performing the control so as to obtain production product within the tolerance limit by inputting the control data to the production process step" (emphasis added).

The claimed method can achieve automatic control of a production process attained by computer-supported control operations based on on-line analysis of the production product. According to the claimed method, a data base is constructed from the results of near-infrared absorptiometry applied to production product, which can be with respect to, for example, constituents in the product, their concentrations, and by-products and their concentrations. Each near-infrared absorbance spectrum for each of a plurality of standard samples is taken in an analysis range including the near-infrared region of the spectrum. For example, the analysis wave length range can be from 800 nm to 2,500 nm (see claims 5 and 14). Such a procedure is performed for each of a plurality of collected samples (for example, 20-30 samples). The standard samples are of "rated" production product, which had been judged by conventional chemical analysis to be rated products. See, for example, EXAMPLES 1-3 at pages 25-31 of the present specification, and Figs. 4, 5, 10 and 12. The

resulting spectral charts are stored in the computer. For each resulting near-infrared absorbance spectral chart, a differentiation function (preferably a secondary differentiation function, as recited in claims 9 and 18) is derived by operation of the computer. Then, average intensity of the standard samples (standard average intensity), i.e., the base line (average intensity level on the differentiation spectral chart), and average standard deviation at each wave length selected on the differentiation spectral chart at a selected interval are calculated and the results are stored in the data base.

Then, an absorbance spectrum in the analysis range for each analysis sample collected from the production process step is taken and compared with the data base. Therefore, it is made possible by embodiments of the claimed method that a delicate variation in, for example, a process condition, can be identified from a selected range of wave lengths using near-infrared absorptiometry without resort to preparation of a calibration curve. See, for example, the description at page 14, line 7, to page 15, line 14, of the present specification.

By the claimed method, control data for controlling the process are obtained by comparing, when the absorbance spectrum includes wave length(s) at which the analysis deviation is outside a tolerance limit, the absorbance at such wave length showing the analysis deviation outside the tolerated limit with that for production information in the data base and the obtained control data are inputted to the production process step in order to obtain production product of a quality within the tolerance limit.

Regarding near-infrared (NIR) spectrometric analysis, a general theoretical treatment of this analysis is described, for example, in the Japanese technical book

"Kin-Sukiyaki Bunseki-Hou Nyumom" (A Primer for Near-Infrared Spectrometric Analysis Method) published from Saiwai Shobo, edited by Mutsuo Iwatani et al., issued on 10th September 1994. A copy of pages 50-73 is attached hereto together with an English-language translation of relevant portions thereof as **Exhibit I**.

As described in Exhibit I, in NIR spectrometry, not only the absorbance intensity at spectral peaks for specific constituent chemical species, but also the wave length thereof, may vary in accordance with conditions, such as the moisture content, temperature, concentration of the constituent, form of the sample to be observed (particle size), etc. See Fig. 3.7 at page 52. For this reason, conventional practice has been based on a technique in which a model is built up by statistical analysis of the spectrometric results and the results of chemical analysis for samples of a standard product, from which a calibration equation is derived for estimating a prospective value (assessed value). Such a calibration requires re-establishment or correction upon each variation in conditions using a number of standard samples for each correction. Disadvantages of preparing such calibration curves are described at page 3, line 10, to page 4, line 24, of the present specification.

McDonald discloses a method for online control of a process plant including steps that produce a product with a property P having a desired value D. In the method, a spectral chart is obtained in which the observed spectral data are subjected to correction using calibration samples to produce a set of corrected spectra for the set of calibration samples. The technique is based on the presupposition that observed spectral data involve deviations from ideal values. The technique disclosed in McDonald falls within the techniques having resort to use of a calibration curve. See column 4, lines 52-64, of McDonald. McDonald discloses

defining the property P of the production product by determining an estimated value E for this property for a test sample from a predictive model and the corrected spectrum of the test sample, and defining a measure of controlling the process using a calculated difference between the estimated value and the desired value of the property P. The predictive model can be determined by a linear least squares regression.

McDonald's method requires extensive work for collecting c properties and/or composition data for each of the n calibration samples to form a matrix Y, and for determining the contemplated material properties, such as Mooney viscosity, degree of unsaturation, etc., of each sample. See, for example, the description at column 6, line 64, to column 7, line 24, and also Figs. 4 and 5 (showing predicted values for Mooney viscosity and unsaturation, respectively).

In contrast to McDonald, the claimed method does not include the preparation of a calibration curve (i.e., creation of a predictive model for the value of the characteristic), and observed data are compared with data in the data base constructed in a form of a differentiation function of the spectral chart, but not with those of a predicted model (corresponding to the conventional technique of comparison with a calibration equation). Also, in the claimed method, comparison of data is at selected wave lengths (for example, at a constant interval), but not at the wave lengths at specific characteristic spectral peaks as in the technique used in McDonald. In the claimed method, comparison with the data base permits finding out what the control factor is. See EXAMPLES 1 to 3 of the present specification and corresponding Figs. 5 to 12.

Accordingly, McDonald does not disclose or suggest the combination of features of the method recited in claim 1, including the features of “constructing a data base from a differentiation curve of a near-infrared spectrum chart obtained using a plurality of production products that had been judged by conventional chemical analysis to be rated products, by calculating standard deviations and the average intensity of the standard samples (standard average intensity) in respect of each wave length selected from the spectrum included in the said analysis range” and “taking an absorbance spectrum in the said analysis range for each analysis sample collected from the production process step and comparing the resulting absorbance spectrum with the data base.”

McDonald also does not disclose or suggest the claimed features of “comparing, when the absorbance spectrum includes wave length(s) at which the analysis deviation of the absorbance spectrum of the analysis sample is outside a tolerance limit, the wave length showing the analysis deviation of the absorbance spectrum outside the tolerance limit with production information given preliminarily in the data base in order to find out what the control factor is to thereby obtain control data.”

For the foregoing reasons, the method recited in claim 1 is neither anticipated nor rendered obvious by McDonald.

The claims dependent from claim 1 are also patentable over McDonald. As discussed above and as described at page 4, lines 4-18, of the present specification, conventional techniques that use a calibration curve include only information for limited wave lengths and do not permit grasp of the entire aspects or of a delicate variation of the nature of the product to be observed. In contrast, the claimed

method constructs a data base from a differentiation curve of a NIR spectrum chart, with calculation of standard deviations and the average standard intensity at each selected wave length. For example, the wavelengths can have an interval of 10 nm or less (see claim 6), or an interval of 2 nm or less (see claim 7) in embodiments of the claimed method. The claimed method permits comparison of the value at the wave length showing the analysis deviation of the absorbance spectrum outside the tolerance limit with the production information in the data base in order to find out what the control factor is.

By performing the near-infrared absorptiometric method for controlling production processes according to the claimed method, it is not necessary to prepare a calibration curve for each element for the analysis and the control of, for example, constituent components, material properties and so on, of each analysis sample. The claimed method can be used to judge whether a product is "rated" (i.e., judged within the tolerance limit) or "extra-rated" (i.e., judged outside the tolerance limit; see page 11, lines 19-25), by simply discriminating as to whether the absorbance spectral intensities at selected wave lengths in the analysis range are within, or outside of, the tolerance limit by comparing the absorbance spectra at the selected wave lengths with the data base. Embodiments of the claimed method makes possible regaining normal operation of a production process by a simple operation at an improved accuracy by performing control of the process using the results obtained. According to the claimed method, effecting control of the process, or of the analysis, is simplified because qualitative estimation of the constituent components and of material properties of the product can be dispensed with. By using as standard samples those which have been approved to be rated by

conventional chemical analysis, analysis accuracy can be increased. Because no calibration curve is used, correction of a calibration curve is unnecessary.

To demonstrate technical advantages that can be provided by embodiments of the claimed method, an exemplary application of the claimed method to on-line detection of production disorder in a glycol purification process was performed. The content of impurities (by-produced glycoles) in the purification process for glycol synthesis product was monitored by a conventional method based on near-infrared ray calibration equation and the result thereof was compared with the result obtained by the claimed method. Test results are shown in Figs. 1-3 attached hereto as **Exhibit II**. In attached Figs. 1 and 2, the results obtained by the conventional method with gas-chromatography analysis and near-infrared spectrophotometry in the wave length range of 1650 nm to 1900 nm are shown. Fig. 1 shows that the impurity concentration (near-infrared predicted value) varies from about 0.9% to about 0.55% over the time period of from December 18, 2003 to January 8, 2004. Observed predicted values were verified at a constant frequency by gas-chromatography analysis. Fig. 2 shows variation in the detected standard deviation σ over the near-infrared wave length range of 1100 nm to 2000 nm by plotting each data point for each observation date. As shown, the detected standard deviation exceeds the tolerance limit of $\pm 3\sigma$ after the date of December 23, 2003 with a maximum deviation (-20σ) determined on December 30, 2003.

Detection results of a standard deviation observed by the claimed method at a wave length of 1908 nm are shown in attached Fig. 3. By performance of the claimed method at wavelengths of ca 1650, 1750 and 1900 nm, the extra-deviation at 1908 nm was detected without having resort to preparation of a calibration curve.

In contrast, as shown in attached Fig. 1, the conventional method failed to detect the extra-deviation at 1908 nm. From the assignment of wave length to impurity chemical species, the essential impurity was estimated to be water, which allowed the process problem of leakage of water into the process line to be detected promptly.

For the foregoing reasons, withdrawal of the rejection is respectfully requested.

Conclusion

For the foregoing reasons, allowance of the application is respectfully requested. If there are any questions concerning this response, the Examiner is respectfully requested to contact the undersigned at the number given below.

Respectfully submitted,

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